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高パルスエネルギー全正常分散モード同期ファイバーレーザ

High-Pulse-Energy All-Normal-Dispersion Mode Locked Fiber Laser

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Mode-locked lasers have been found many important applications such as frequency metrology, supercontinuum source generation and fusion laser system. Compared with solid state mode locked lasers, mode locked fiber lasers especially have advantages in their low cost, compactness and virtually maintenance-free operation. However, the pulse energy and the pulse power of mode locked fiber laser are far below of solid state mode locked laser because of the nonlinear effect in fiber. Typical mode locked fiber lasers only have pulse energy from a few hundred picojouls to a few nanojouls[i].

Here we describe an all-fiber, all-normal-dispersion mode locked laser of which the pulse energy can be over 20nJ. Schematic setup is shown in Figure 1. We used nonlinear polarization rotation regime with two polarization controllers (PCs) and a polarizer to make mode locking and introduce temporal filtering effect. An isolator (ISO) was used to ensure unidirectional operation. The Yb-doped gain fiber (YDF) of which length had 8m was used. A laser diode with central wavelength of 976nm was used to pump YDF through a wavelength-division multiplexing (WDM). About 100m of single mode fiber was inserted to increase the nonlinear effect and induce large normal dispersion. The output was coupled out through 70/30 coupler.

Above certain threshold pump power and by rotating the PC properly, stable mode locking was achieved. The spectral and the power did not change after 12 hour but had certain reduction in power and spectral bandwidth after 24 hour. The spectral bandwidth was 18nm observed by optical spectral analyzer shown in Figure 2. The repetition rate was 1.51MHz measured by a RF spectrum analyzer. The pulse-width, inferred from the autocorrelator trace shown in Figure 3, had duration of 330fs assuming a sech-pulse shape. The time bandwidth product (TBP) was 1.6, which means the pulse was highly chirped. The output power was 14.9dBm and the pulse energy was 21nJ when pump power was 260mW. Above this pomp power, little peak-like noise began to appear in spectra and multiple pulses were observed by oscilloscope.

Practically, our high energy pulses can be applied in supercontinuum generation and optical coherent tomography measurements.

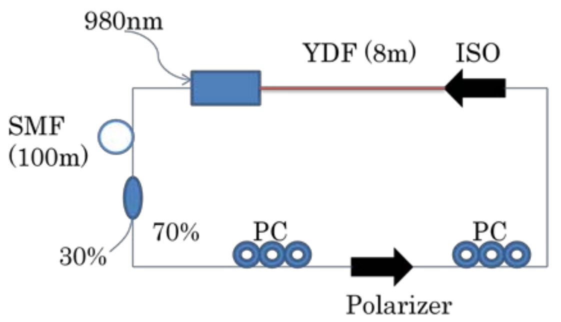

Figure 1 Schematic setup

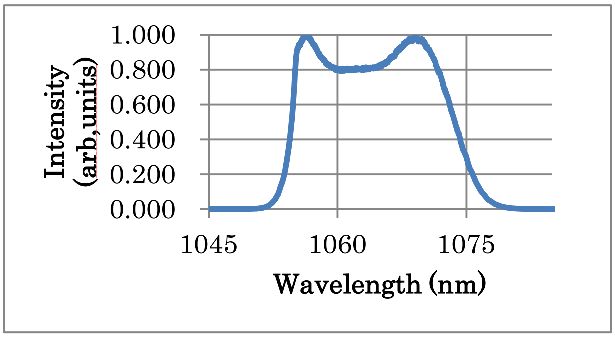

Figure 2 Optical spectra

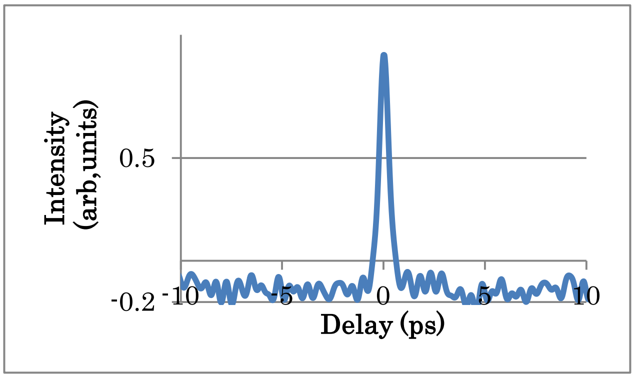

Figure 3 Interferomatric autocorrelation

[i] H. Lim, F. Ö. Ilday, and F. W. Wise, " Generation of 2-nJ Pulses from a Femtosecond Ytterbium Fiber Laser," Opt. Lett., Vol. 28, No. 8, pp. 660-663, 2003